MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2017/2018

DEM5018 – ENGINEERING MATHEMATICS 1

(Diploma in Electronic Engineering)

4 JUNE 2018
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **6** pages (**3** pages with **4** questions and **3** pages for appendix)
2. Answer **ALL** questions. All necessary working steps must be shown.
3. Write all your answers in the answer booklet provided.

QUESTION 1 [25 Marks]

a) Solve the inequality $\frac{(x+5)(x-4)}{x^2-9} \geq 0$. Graph the solution set on a number line.

[11 marks]

b) Referring to Figure 1, point A is the center of Circle$_1$. The circle passes through the points B (0, 0), C (10, 2), D (2, −10) and E (12, −8). Line$_1$, BAE and Line$_2$, CAD are linear lines.

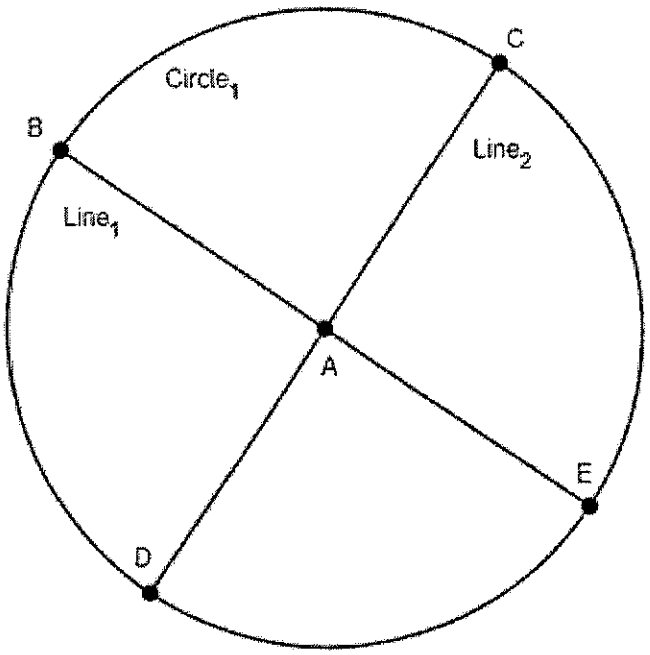

Figure 1

(i) Find the linear equation for Line$_1$ in point-slope form.

[2 marks]

(ii) Find the linear equation for Line$_2$ in slope-intercept form.

[2 marks]

(iii) Determine the coordinate of center of Circle$_1$, by solving the equation in (i) and (ii) simultaneously.

[6 marks]

(iv) Determine the radius of Circle$_1$.

[2 marks]

(v) State the equation of Circle$_1$ in standard form.

[2 marks]

Continued...

QUESTION 2 [25 Marks]

a) Solve the trigonometric equation $4\cos^2\theta - \cos 2\theta - \cos\theta = 2$ on the interval $[0, 360°]$.

[9 marks]

b) Given $p = -6 + 4i$ and $q = 12 - 5i$,

(i) Convert both complex number into polar form.

[6 marks]

(ii) Solve $\dfrac{p^3 q}{1000(\cos 30° + i\sin 30°)}$ in polar form. Convert your final answer into rectangular form.

[10 marks]

QUESTION 3 [25 Marks]

a) Solve the system of equations below using inverse matrix method.

$$\begin{cases} 4x + 2y - z = -13 \\ x - 3y + 4z = 40.5 \\ 10x - z = -2 \end{cases}$$

[15 marks]

b) Solve the following limits,

(i) $\lim\limits_{x\to 2} \dfrac{x^2 - 6x + 8}{x^2 - 4}$

[4 marks]

(ii) $\lim\limits_{x\to \infty} \dfrac{12x^4 + 15x^3 - 2}{3x^4 - 7x^2 + 9}$

[6 marks]

Continued...

QUESTION 4 [25 Marks]

a) Find $f'(x)$ for the following function using logarithmic differentiation. Simplification of final answer is not necessary.

$$f(x)=\frac{x^7 e^x \cos^4 2x}{\sqrt{x+1}}$$

[10 marks]

b) Based on the function $f(x)=\frac{x^2}{x^2-4}$,

(i) Determine the coordinate(s) of the function's critical point(s).

[6 marks]

(ii) Determine the interval(s) of which the function is increasing/decreasing.

[4 marks]

(iii) Sketch the graph of the function based on your answer in (i) and (ii), with the assistance of the following information:

- $x = -2$ and $x = 2$ are the vertical asymptotes
- $y = 1$ is the horizontal asymptote
- x-intercept at $x = 0$
- y-intercept at $y = 0$

[5 marks]

End of Page

APPENDIX

A Standard Form of Circle Equation

$$(x-h)^2+(y-k)^2=r^2$$

B Fundamental Identities

- Even & Odd Properties:
$$\sin(-\theta)=-\sin\theta \qquad \csc(-\theta)=-\csc\theta$$
$$\cos(-\theta)=\cos\theta \qquad \sec(-\theta)=\sec\theta$$
$$\tan(-\theta)=-\tan\theta \qquad \cot(-\theta)=-\cot\theta$$

- Reciprocal identities:
$$\csc\theta=\frac{1}{\sin\theta},\ \sec\theta=\frac{1}{\cos\theta},\ \cot\theta=\frac{1}{\tan\theta}$$

- Pythagorean identities :
$$\sin^2\theta+\cos^2\theta=1$$
$$\tan^2\theta+1=\sec^2\theta$$
$$1+\cot^2\theta=\csc^2\theta$$

- Sum/Difference Formula for Cosine:
$$\cos(A\pm B)=\cos A\cos B\mp\sin A\sin B$$

- Sum/Difference Formula for Sine:
$$\sin(A\pm B)=\sin A\cos B\pm\sin B\cos A$$

- Sum/Difference Formula for Tangent:
$$\tan(A\pm B)=\frac{\tan A\pm\tan B}{1\mp\tan A\tan B}$$

- Double Angle Formula:
$$\cos 2A=\cos^2 A-\sin^2 A$$
$$=1-2\sin^2 A$$
$$=2\cos^2 A-1$$
$$\sin 2A=2\sin A\cos A$$
$$\tan 2A=\frac{2\tan A}{1-\tan^2 A}$$

- Half Angle Formula:
$$\sin\left(\frac{\alpha}{2}\right)=\pm\sqrt{\frac{1-\cos\alpha}{2}}$$
$$\cos\left(\frac{\alpha}{2}\right)=\pm\sqrt{\frac{1+\cos\alpha}{2}}$$
$$\tan\left(\frac{\alpha}{2}\right)=\pm\sqrt{\frac{1-\cos\alpha}{1+\cos\alpha}}$$

C Relations between Polar and Rectangular Coordinates

$x = r\cos\theta$; $y = r\sin\theta$; $r = \sqrt{x^2 + y^2}$; $\tan\theta = \frac{y}{x}$

D Products and Quotients in Polar Form

- $z_1 z_2 = r_1 r_2[\cos(\theta_1 + \theta_2) + i\sin(\theta_1 + \theta_2)]$
- $\frac{z_1}{z_2} = \frac{r_1}{r_2}[\cos(\theta_1 - \theta_2) + i\sin(\theta_1 - \theta_2)]$; $z_2 \neq 0$

E DeMoivre's Theorem

- Powers of Complex Numbers on Polar Form:
  $z^n = r^n(\cos n\theta + i\sin n\theta)$
- Roots of Complex Numbers in Polar Form:
  $z_k = \sqrt[n]{r}\left[\cos\left(\frac{\theta}{n} + \frac{2\pi k}{n}\right) + i\sin\left(\frac{\theta}{n} + \frac{2\pi k}{n}\right)\right]$
  $k = 0, 1, 2, \ldots, n-1$

F Derivatives of Trigonometric Functions

$\frac{d}{dx}[\sin x] = \cos x$ $\frac{d}{dx}[\cos x] = -\sin x$ $\frac{d}{dx}[\tan x] = \sec^2 x$

$\frac{d}{dx}[\sec x] = \sec x\tan x$ $\frac{d}{dx}[\cot x] = -\csc^2 x$

$\frac{d}{dx}[\csc x] = -\csc x\cot x$

G The Chain Rule

If $y = f[g(x)]$ and $u = g(x)$, then $y = f(u)$:

$\frac{dy}{dx} = \frac{dy}{du}\cdot\frac{du}{dx}$ *or* $\frac{d}{dx}[f(u)] = f'(u).\frac{du}{dx}$

H Derivative of the Exponential & logarithmic Function

$\frac{d}{dx}[e^x] = e^x$; $\frac{d}{dx}[e^u] = e^u.\frac{du}{dx}$; $\frac{d}{dx}(a^x) = a^x\ln a$

$\frac{d}{dx}[\ln x] = \frac{1}{x}$; $x > 0$; $\frac{d}{dx}[\ln u] = \frac{1}{u}.\frac{du}{dx}$; $\frac{d}{dx}\log_a x = \frac{1}{\ln a}\cdot\frac{1}{x} = \frac{1}{x\ln a}$

I Derivative of Inverse Trigonometry Function

$$\frac{d}{dx}\left[\sin^{-1}x\right]=\frac{1}{\sqrt{1-x^2}} \qquad \frac{d}{dx}\left[\cos^{-1}x\right]=-\frac{1}{\sqrt{1-x^2}} \qquad \frac{d}{dx}\left[\tan^{-1}x\right]=\frac{1}{1+x^2}$$

$$\frac{d}{dx}\left[\csc^{-1}x\right]=-\frac{1}{x\sqrt{x^2-1}} \qquad \frac{d}{dx}\left[\sec^{-1}x\right]=\frac{1}{x\sqrt{x^2-1}} \qquad \frac{d}{dx}\left[\cot^{-1}x\right]=-\frac{1}{1+x^2}$$

J Derivative of Hyperbolic Function

$$\frac{d}{dx}[\sinh x]=\cosh x \qquad \frac{d}{dx}[\cosh x]=\sinh x \qquad \frac{d}{dx}[\tanh x]=\sec h^2 x$$

$$\frac{d}{dx}[\sec hx]=-\sec hx\tanh x \qquad \frac{d}{dx}[\coth x]=-\csc h^2 x$$

$$\frac{d}{dx}[\csc hx]=-\csc hx\coth x$$

K The Second Derivative Test

Suppose f'' is continuous near c.

If $f'(c)=0$ and $f''(c)>0$, then f has local minimum at c.

If $f'(c)=0$ and $f''(c)<0$, then f has local maximum at c.

L Linear Approximation

Linearization of f at a, $L(x)$, is given by:-

$L(x)=f(a)+f'(a)(x-a)$